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September 30, 2008 *Also Sent Via E-mail*

Tom McCue, Environmental Manager
Siltronic Corporation
7200 NW Front Avenue
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Re: Enhanced In-Situ Bioremediation Work Plan and Addendum
Siltronic Corporation
Portland, Oregon
ECSI No. 183

Dear Mr. McCue:

The Department of Environmental Quality (DEQ) reviewed the following documents:

- "Enhanced Bioremediation Source Control Work Plan," dated May 12, 2008 (EIB Work Plan); and
- "Addendum to the Enhanced Bioremediation Source Control Work Plan – Phase I Injection Plan," dated August 19, 2008 (Phase I Injection Plan).

Maul Foster Alongi, Inc. prepared the EIB Work Plan and Phase I Injection Plan on behalf of the Siltronic Corporation (Siltronic).

The primary purpose of this letter is to inform Siltronic that DEQ does not approve the EIB Work Plan and Phase I Injection Plan. DEQ has determined the EIB Work Plan should be revised to include an overall approach for implementing enhanced in-situ bioremediation[1] (EIB) in the vicinity of the former solvent underground storage tank system (e.g., injection and performance monitoring plans for all phases of EIB injection) consistent with the comments provided below.

BACKGROUND

Under DEQ Order No. VC-NWR-03-16 (the VOC Order), Siltronic is required to: 1) conduct a remedial investigation (RI) of releases of "trichloroethene (TCE) and its degradation byproducts and/or additives" (collectively referred to as "VOCs" in this letter); and 2) for unpermitted discharges or releases of VOCs to the Willamette River, identify and implement source control measures (SCMs), if necessary.

Consistent with Item #1 above, Siltronic submitted an RI Report[2] that documents: 1) historic releases of VOCs from a former solvent underground storage tank system (Former UST System)

[1] Enhanced in-situ bioremediation involves injecting a slurry of controlled-release carbon and zero-valent iron (i.e., EHC) into the subsurface, followed by bioaugmentation with a commercial culture of VOC-degrading dehalobacteria (i.e., KB-1).
[2] Maul Foster Alongi, Inc., 2007, "Remedial Investigation Report, Siltronic Corporation – Portland, Oregon," April 16, a report prepared on behalf of the Siltronic Corporation.

have impacted groundwater beneath the northern portion of the property owned by Siltronic (Siltronic Property); 2) groundwater is a complete contaminant transport pathway from the Former UST System to the Willamette River; and 3) VOCs are present in groundwater and transition zone water immediately beneath the river at concentrations that exceed Joint Source Control Strategy[3] (JSCS) screening criteria.

Based on the RI and site investigations conducted by NW Natural, DEQ determined the northern portion of the Siltronic Property and the shoreline of the adjoining Gasco Site (i.e., property owned by NW Natural) are high priorities for source control. The portion of the shoreline identified as the highest priority for source control (Segment 1) coincides with the heaviest manufactured gas plant (MGP) contamination identified near the river resulting from historic operations of the Gasco Site, including dense non-aqueous liquids (DNAPLs) and impacted riverbank soils and groundwater. It also includes the portion of the Siltronic Property where groundwater contamination caused by Siltronic has commingled with MGP-related DNAPL and MGP impacted groundwater.

Consistent with the requirements of the VOC Order and DEQ's source control determination, Siltronic developed the VOC Plume FFS[4] that recommended EIB be used to treat VOCs in groundwater along the shoreline of the river and in the vicinity of the Former UST System. In a letter dated February 14, 2008 (February 14th Letter), DEQ accepted Siltronic's recommendation to use EIB in the vicinity of the Former UST System, but not along or near the shoreline. The U.S. Environmental Protection Agency provided their agreement with DEQ's decision during a meeting with Siltronic and DEQ on May 27, 2008.

The EIB Work Plan and Phase I Injection Plan provide Siltronic's approach to using EIB in the vicinity of the Former UST System. The two submittals are companion documents. The EIB Work Plan presents Siltronic's proposed approach to using EIB in the vicinity of the Former UST System, and includes recommendations for conducting drilling and sampling work to further characterize the nature and extent of contamination, a preliminary injection zone design (i.e., saturation approach in the immediate vicinity of the Former UST System), the numbers and locations of monitoring wells to assess EIB performance, and a performance monitoring program. The Phase I Injection Plan presents the results of the supplemental drilling and sampling work and, based on this work, Siltronic's recommendation for injecting EIB in phases. The plan for the first phase of EIB injection is provided in the document.

DEQ's comments regarding the EIB Work Plan and the Phase I Injection Plan are provided below.

[3] EPA and DEQ, 2005, "Portland Harbor Joint Source Control Strategy – Final," December (note Table 3-1 revised July 16, 2007), a guidance document prepared jointly by the US Environmental Protection Agency and Oregon Department of Environmental Quality.
[4] Maul Foster Alongi, Inc., 2007, "Focused Feasibility Study, Siltronic Corporation, Portland, Oregon," October 23 (amended December 19, 2008), a report prepared for Siltronic Corporation.

GENERAL COMMENT

As noted by Siltronic in Section 2 of the EIB Work Plan, DEQ included, "…preventing expansion of the VOC plume in the downgradient direction," in modifying the remedial action objectives (RAOs) for EIB in the Former UST System.

Although not mentioned in the EIB Work Plan, the February 14th Letter refers Siltronic to additional clarifying text (i.e., the 6th condition in the first group of bullets under "Source Control Measures Planning and Design") in which DEQ:

- Agreed with Siltronic that EIB resulted in significant decreases in TCE concentrations near the Former UST System (i.e., the "source zone pilot study area" [SZPSA]).
- Observed that after increasing post-injection, concentrations of cis-1,2-dichloroethene (cis-1,2-DCE) were maintained and vinyl chloride (VC) concentrations increased by orders of magnitude downgradient of the SZPSA.
- Expressed concern that the nature of the VOC plume had shifted from being TCE-dominated to having cis-1,2-DCE and VC as the principal constituents.

Based on this information, DEQ informed Siltronic the pilot study results for the SZPSA showed promise for EIB, however the buildup and persistence of TCE daughter products in the WS-18-71/101 monitoring well cluster located 20 feet downgradient needed to be resolved for full-scale application. DEQ indicated the RAOs for EIB should include establishing declining cis-1,2-DCE and VC concentration trends downgradient of the Former UST System treatment zone(s). This issue was not addressed in either the EIB Work Plan or the Phase I Injection Plan. As proposed in the Phase I Injection Plan, the permeable reactive barrier (PRB) is essentially a scaled up version of the pilot scale application. As such, DEQ anticipates groundwater concentration trends downgradient of the PRB will mimic those observed at WS-18-71/101.

Based on the results of the pilot study and available data DEQ concludes: 1) the potential for significant daughter product concentrations to persist and migrate under the Fab 1 building is high; and 2) scaling up EIB to duplicate the performance of the pilot study will not achieve RAOs. DEQ does not consider it acceptable to allow "slugs" of daughter products to migrate under Fab 1 for extended periods of time, especially without monitoring groundwater between the upgradient and downgradient sides of the Fab 1 building. In addition, supplemental delineation work determined the area upgradient (southwest) of Fab 1 with TCE concentrations exceeding 1% of the TCE aqueous phase solubility (i.e., 11,000 micrograms per liter [ug/L], or parts per billion) is much larger than previously thought, and includes a new shallow source of contamination (e.g., at borings GP-117 and GP-124).

Siltronic mentions in the Phase I Injection Plan that additional phases (i.e., phases II and III) of EIB injections will follow Phase I, however information regarding the scope and schedules for these phases is not presented in the addendum. As such, there is insufficient information for DEQ to determine if and how the issues outlined above are being incorporated into the overall EIB injection plan, and/or how Siltronic proposes to meet RAOs.

DEQ expects Siltronic to revise the EIB Work Plan to incorporate the addendum and provide:

- Injection plans for the Phase II and Phase III EIB applications, including the basis, rational, and goals for each phase, and the injection area location(s), depths, and performance monitoring well (PMW) locations and monitoring objectives;
- Implementation sequence and schedules for EIB injections and PMW installations;
- Discussions of how phasing EIB injections will achieve the RAOs; and
- Contingencies for further enhancing VOC degradation after phased EIB injections are completed, if warranted to meet RAOs.

Absent this information, DEQ cannot approve Siltronic moving forward with using EIB in the Former UST System vicinity.

SPECIFIC COMMENTS

EIB Work Plan

Section 1.1. In the last paragraph of the section Siltronic indicates, "Siltronic's cooperation with NWN [on the shoreline hydraulic control/containment system], with implementation of EIB in the source area, will therefore fulfill Siltronic's obligations under the [VOC] Order." For clarification, DEQ acknowledges Siltronic has satisfied its obligations under the VOC Order to identify and evaluate source control measures (SCMs) for the groundwater pathway. The VOC Order will remain in place however, until DEQ accepts the RI as being complete and determines that, with regard to VOC migration to the Willamette River: 1) all contaminant transport pathways have been characterized, and 2) implemented SCMs effectively address contaminant migration.

Section 1.2.2. Siltronic indicates that VOC concentration trends shown by figures 1-5 and 1-6 are evident in figures 1-3 and 1-4. DEQ disagrees with Siltronic's interpretation of the data. Subsequent to EHC/KB-1 injection, cis-1,2-DCE) and VC concentrations increased at WS-18-71/101 by orders of magnitude. Except for cis-1,2 DCE at WS-18-71, concentrations of cis-1,2-DCE and VC at monitoring wells WS-18-71/101 appear to have been maintained at concentrations of approximately 100,000 ug/L and greater than 10,000 ug/L for cis-1,2-DCE and VC respectively. As such, the data through January 2008 do not exhibit the downward trends indicated by figures 1-3 and 1-4.

Section 2.1. In the February 14, 2008 Letter, DEQ indicated the potential for extraction wells located along the shoreline to influence hydraulic gradients operating in the vicinity of the Former UST System is a consideration for scaling up EIB. Siltronic indicates detailed modeling of this situation has not been completed, and implies downgradient expansion of the VOC plume is unlikely if EIB is implemented in advance of groundwater extraction. For clarification, as part of EIB scale-up planning Siltronic should assess hydraulic gradients under reasonable worst-case pumping conditions using analytical or purpose-specific numerical methods. This comment also applies to Section 4.1.

Section 2.4. Groundwater monitoring data collected near the river indicate VOC concentrations: 1) exceed JSCS criteria over depth intervals of greater than 50 feet; and 2) vary substantially over relatively short depth intervals (e.g., monitoring wells WS-11-125 and WS-21-112). Given this information, Siltronic's proposal to monitor groundwater using single-completion PMWs does not provide adequate vertical coverage to fully assess EIB performance downgradient of Fab 1. The numbers, locations, and depths of PMWs should be modified as follows:

- The locations of PMWs "105-115" and "55-65" should be shifted as close to the northeastern wall of Fab 1 as practicable given site access restrictions and equipment limitations.
- Double-completion clusters should be installed at selected PMW locations, including "105-115," "100-110," and "65-75." An additional deeper PMW should also be installed near WS-21-112. The depth intervals of PMWs should be selected to provide groundwater data representative of the highest concentration portions of the VOC plume at each location.
- An additional PMW should be installed to monitor groundwater between the WS-14 cluster and the Former UST System (i.e., near the northern corner of Fab 1).

The performance monitoring plan included in the revised EIB Work Plan should incorporate the modifications listed above.

Section 4.3. The re-injection criteria detailed in this section of the EIB Work Plan appear to rely on pilot study results and focus on timeframes for EIB to degrade VOCs in the Former UST System vicinity. Interim build-up and migration of TCE daughter products are not considered. If EIB injections do not achieve the RAO of having cis-1,2-DCE and VC concentrations on declining trends after leaving the EIB treatment zone(s), then Siltronic should have a contingency plan in place to further enhance degradation. For example, using an angled injection approach to distribute EIB treatment media closer to or under Fab 1 may be warranted (see Figure 10 of the Phase I Injection Plan). This section of the EIB Work Plan should be revised accordingly.

Figure 1-1. The "locality of the facility" (LOF) appears to be drawn based on the interpreted extent of TCE. The LOF should not be limited to TCE, but should take into consideration other VOCs (e.g., cis-1,2-DCE or VC). Figure 1-1 should be reviewed and revised to depict an LOF that encompasses the maximum extent of VOCs exceeding relevant screening criteria.

Phase I Injection Plan

Lithology (page 2). The logs for push-probe borings GP-111, GP-112 and GP-113 referenced here are not included in Attachment 1. Copies of these logs should be provided for DEQ's review and use.

Slug Test Results (page 3). It appears slug test data used for calculation purposes are shown in Attachment 1. If this is the case, DEQ requests complete electronic versions of the each data file be provided as Excel® compatible spreadsheets for completeness.

Flexible Wall Permeability Test Results (page 4). The Lithology section indicates that push-probe borings GP-111, GP-112 and GP-113 were continuously logged. DEQ understood that

samples of the lower silt unit would be selected from these borings for vertical permeability testing. This section of the document indicates samples were selected from borings GP-112, GP-113 and GP-114 for testing. The text from the two referenced sections should be reviewed and revised as appropriate.

Source Modeling (page 7). Siltronic indicates that an 80% UCL was used to "conservatively overestimate" the extent of TCE impacts exceeding 11,000 ug/L. It's not clear from DEQ's review of the document why applying the 95% UCL would underestimate the area where TCE concentrations exceed 11,000 ug/L. DEQ requests Siltronic to further explain this approach to analyzing TCE concentration data by providing relevant EVS model documentation, and figures showing the extent of TCE impacts based on the 95% UCL (e.g., revised versions of figures 3, 4 and 6).

EHC/KB1 Injections (page 11). The injection plan provides descriptions of the lateral (within a row) and vertical injection spacing, but not the number of rows and total injection points. Based on Figure 7 it appears the number of rows being proposed will result in a PRB with the same thickness as the SZPSA. Generally, PRBs are designed to provide adequate groundwater residence time to completely degrade chemicals within the treatment zone. In the case of the PRB proposed by Siltronic, EIB will enhance biodegradation within the shaded treatment zone, but complete treatment will not occur. The goals of the Phase I injection plan, including discussion of the thickness of the PRB, residence time, and treatment completeness should be included in the revised EIB Work Plan.

Monitoring wells (page 9). Performance monitoring should assess groundwater along the length of the downgradient side of the PRB, and provide VOC data over depth intervals with TCE concentrations greater than 11,000 ug/L. To meet these objectives Siltronic should add: 1) a shallower PMW at the GP-112 location; and 2) pending the results of the additional proposed push-probe boring, at least one PMW near GP-122. Depending on Siltronic's Phase II and Phase III injection plans, additional monitoring wells may be warranted to monitor groundwater within or near these treatment zones.

The results of the work completed to date in the Former UST System vicinity, indicate there is the potential for TCE DNAPL to occur in the subsurface. DEQ expects PMWs to be equipped with DNAPL funnels to further assess DNAPL occurrence in the vicinity of the Former UST System where TCE concentrations exceed 11,000 ug/L.

The trigger for implementing contingencies mentioned under DEQ's General Comment and comments to Section 4.3 will rely on groundwater monitoring data collected from PMWs located between the PRB and Fab 1. Monitoring of EIB performance is complicated by the presence of TCE concentrations above 11,000 ug/L downgradient of portions of the PRB. In addition, contingency injections of EIB, if necessary, will alter downgradient groundwater chemistry (best case), and could infiltrate PMW screened intervals (worst case). Given this information, PMWs located between the PRB and Fab 1 may not provide the groundwater data needed to determine

RAOs are being achieved. DEQ continues to consider groundwater monitoring under Fab 1 to be a necessary component of the groundwater monitoring program.

Preliminary discussions with drilling companies indicate equipment is locally available to angle drill beneath Fab 1 and install monitoring wells at depths that could meet the needs of the project (e.g., drilling and installing 2-inch monitoring wells at approximately 45^{o} angles to depths greater than 100 feet vertically bgs). Given this information, DEQ expects the revised EIB performance monitoring plan to include specifications for drilling and installation PMWs under Fab 1.

Injection Boring Completion (page 14). Based on observations made at the Gasco Site and in response to comments from DEQ, NW Natural has completed an evaluation of sealant material compatibility with MGP contaminated groundwater and MGP waste (e.g., mobile DNAPL). From the results of this work NW Natural is recommending a blend of bentonite and Organoclay as an alternative to sodium bentonite or cement-bentonite slurries for sealing borings and/or monitoring wells. NW Natural has submitted a request to utilize the bentonite/Organoclay blend to the Oregon Water Resources Department and DEQ for review. If approved, DEQ will expect Siltronic to use the blend to seal borings and/or monitoring wells where MGP DNAPL may be present.

DEQ appreciates and acknowledges the significant amount of work that has been performed to evaluate using EIB to treat VOCs and implement this technology in the area of the Former UST System. Please call me at (503) 229-5543 if you have questions regarding this letter.

Sincerely,

Dana Bayuk, Project Manager
NWR Cleanup Section

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